

Experimental Platforms on NIF

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Presentation to: NIF and JLF User Group Meeting
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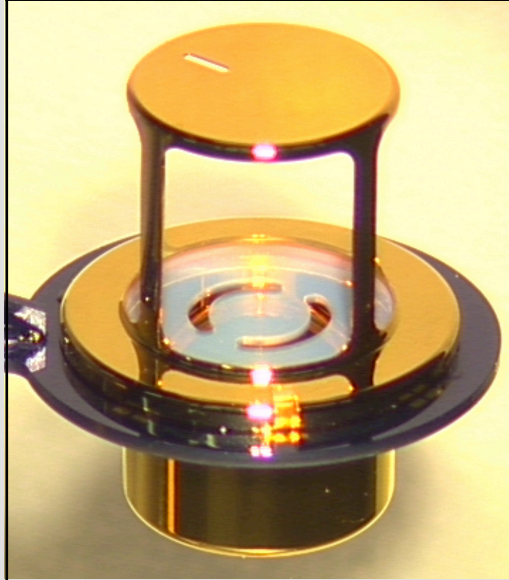
This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

An integrated suite of capabilities to perform an experiment is termed the experimental “platform”

Experimental Platform: “End-station”

Targets

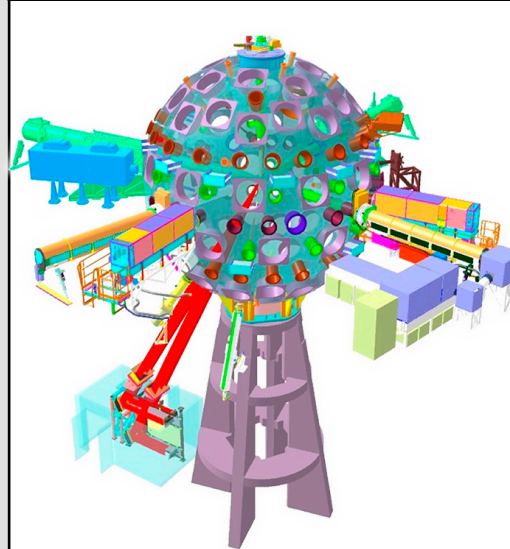
Radiation Transport
Target



Laser

Diagnostics

Facility Integration



Data Analysis

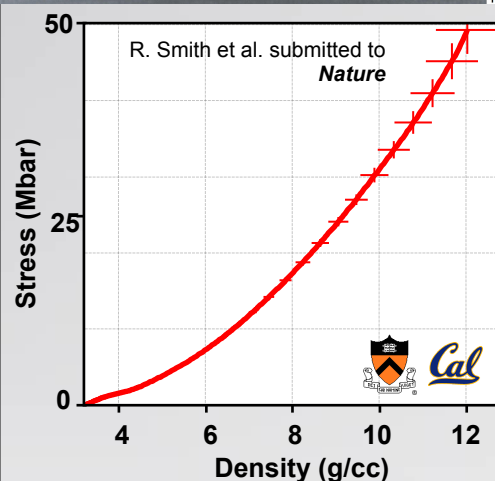
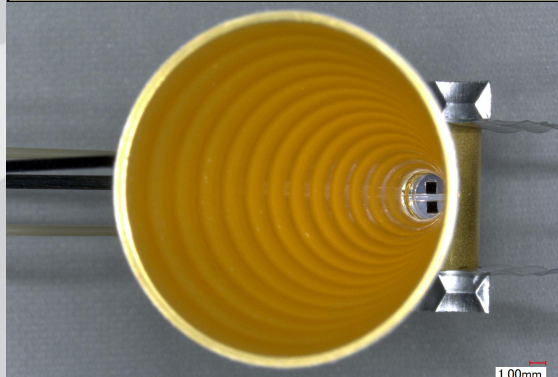
This talk will focus on the regimes and potential physics areas that can be explored using existing platforms

- **The use of existing platforms provides the opportunity to acquire data more readily than developing new platforms**
- **This strategy is consistent with mini-campaigns – more shots, more data**
- **Does not preclude new platforms – a user facility needs to be able to develop new platforms for users if required**
 - **A balance is needed between acquiring data on existing platforms and development of new platforms**

**Providing more opportunities for data is vital for
Fundamental Science on NIF**

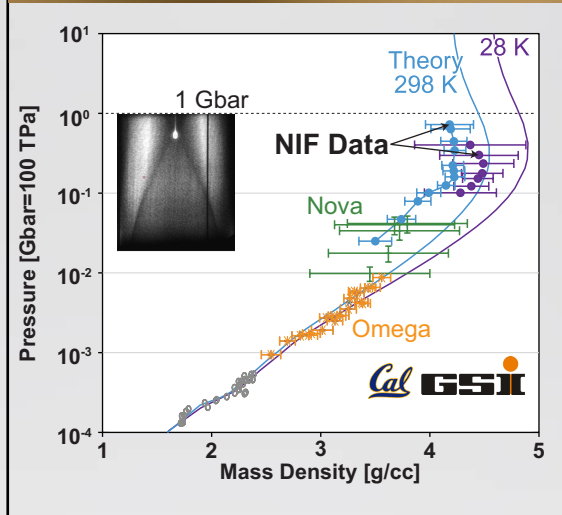
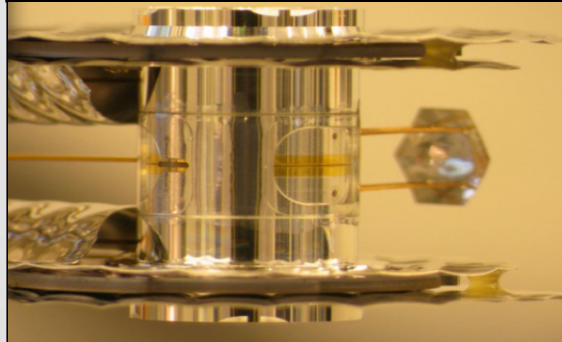
By using an experimental platform that has already been commissioned, physics data can be acquired more readily

C EOS used a HEDSS EOS platform



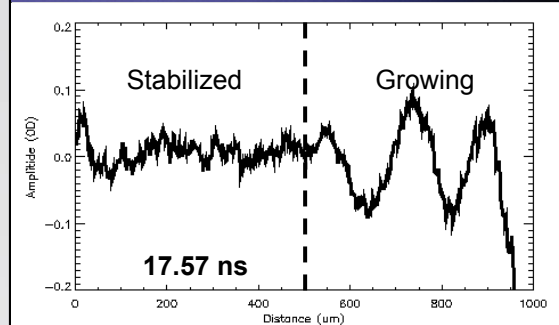
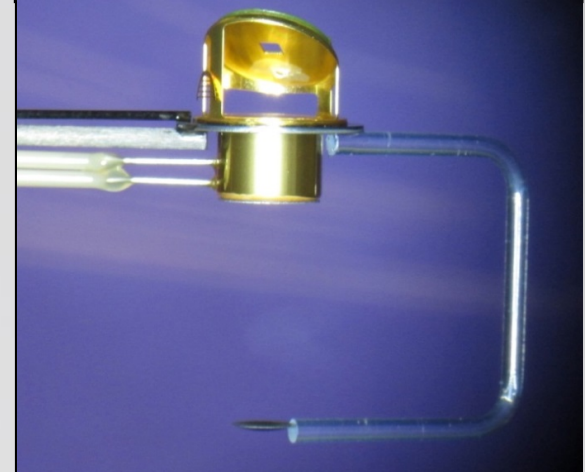
EOS data was acquired on the first shot

Gbar EOS used an ICF ablator imaging platform



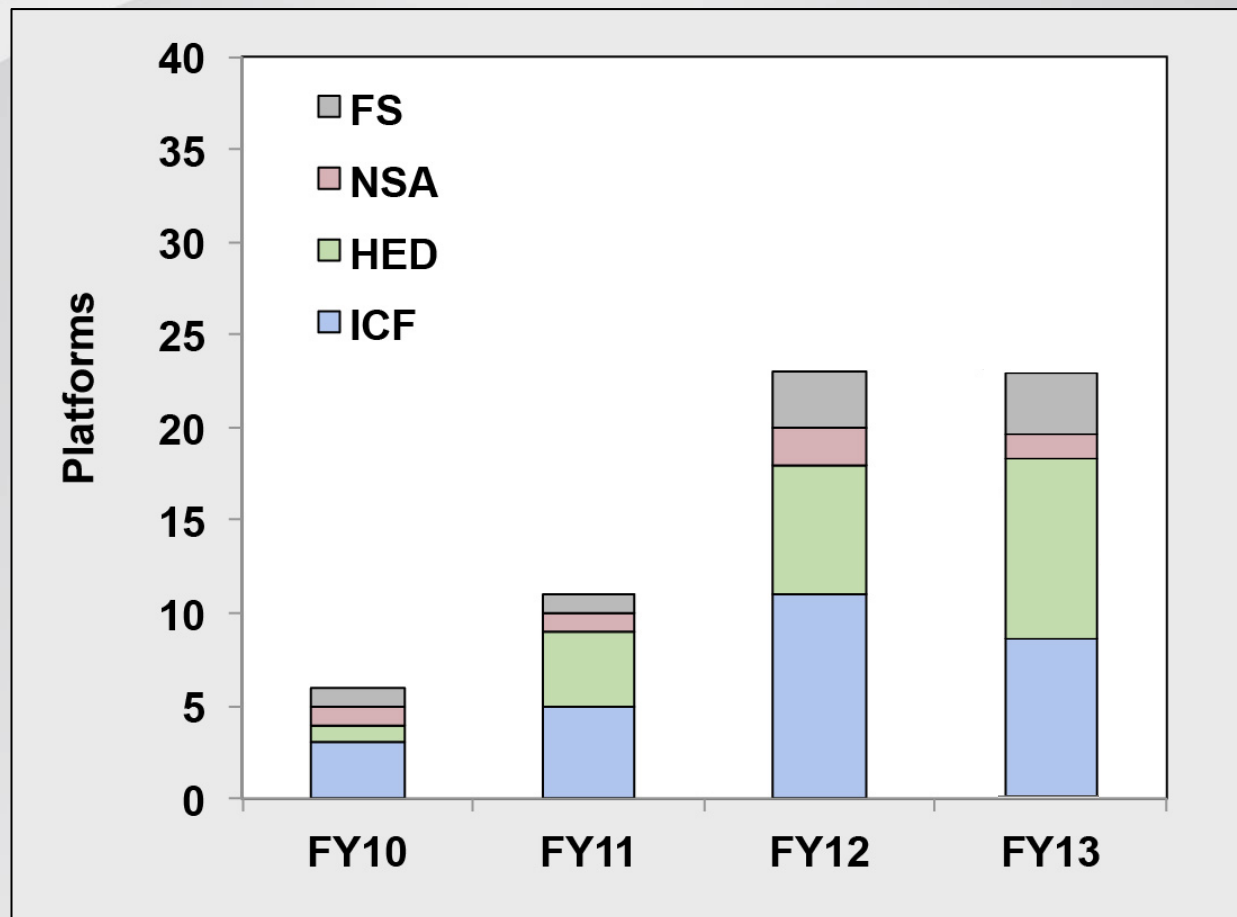
EOS data was acquired on the first shot

Ablative RT growth used a HEDSS radiography platform



Instability data was acquired on the first shot

We have a large number of platforms that have been commissioned by ICF or HEDSS



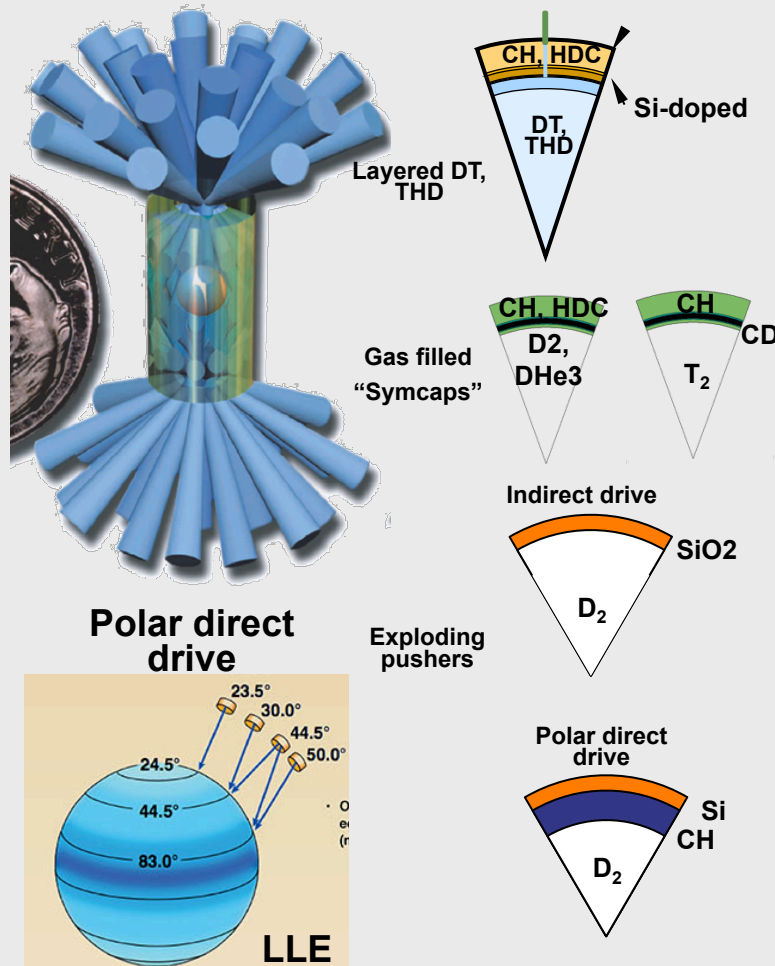
We have ~ 54 platforms currently used for experiments

We continue to commission new experimental platforms

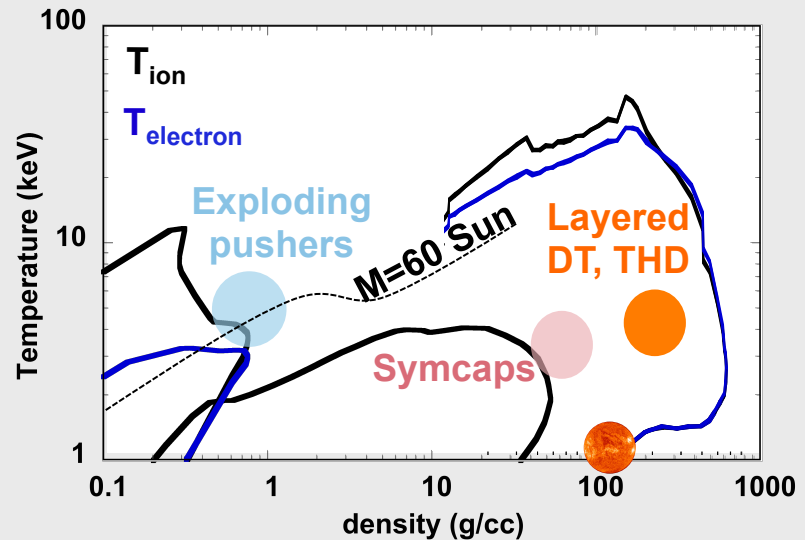
	FY09	FY10	FY11	FY12	FY13	FY14
Implosions & Applications	Hohlraum implosions ★	Direct Drive Exploding pushers ★ ★	Cryogenic DT Implosions	Nuclear Cross Sections ★		
Plasma physics	★ GasPipe					
Radiation - Hydro		Planer Halfraum ★	★ Planer Gas-filled Hohlraum	★ Spherical: Hohlraum		
High pressure EOS and strength			Hohlraum ICE EOS ★ ★	Hohlraum ICE Strength		Diffraction ★
X-ray sources		Low debris 4 KeV source ★	★ Low debris 13 KeV source			

Implosions reach high temperature and/or density conditions

Many different direct and indirect drive capsules have been fielded



Implosions are potential platforms for a multitude of physics

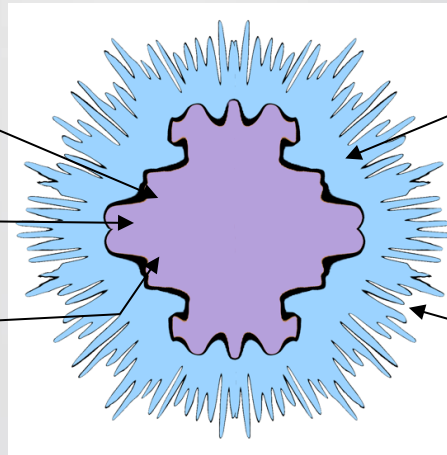


- **Charged particle stopping power**
- **Non-equilibrium atomic physics**
- **Electron-ion equilibration**
- **Moderately coupled plasmas**
- **Mix**
- **Kinetic effects**

A suite of ~ 50 diagnostics are available

Temperature of
Hot Spot (T_{HS})

Radius of Hot
Spot (R_{HS})



ρR_{Total}

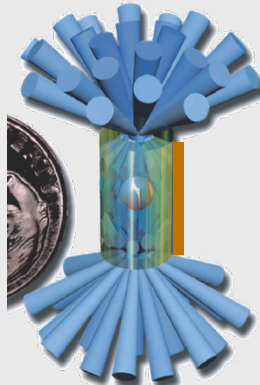
$\Delta R_{mix}/\Delta R_{shell}$

Hot Spot		
T_{HS}	3–4 keV	NTOF20, hGXI, ARIANE, DIXI
$\langle R_{HS} \rangle$	20–30 μm	hGXI, ARIANE, DIXI, NI
Y_n	10^{13-15}	NToF, NAD, MRS, CR39
$t_{burn, bang}$	100–200 ps ~20 ns	hGXI, SPBT, NToF4BT, GRH, SPIDER, ARIANE
mix	30%	hGXI, ARIANE, DIXI, HXRS RAGS

Cold Fuel		
$\langle \rho R \rangle$	$>1 \text{ g/cm}^2$	NToF, WRF MRS, RAGS, ARC, NI
$\Delta \rho R(\theta)$	$<0.2 \text{ g/cm}^2$	MRS, NToF, NI
$\Delta R_{mix}/\Delta R_{shell}$	<0.25	hGXI, DIXI

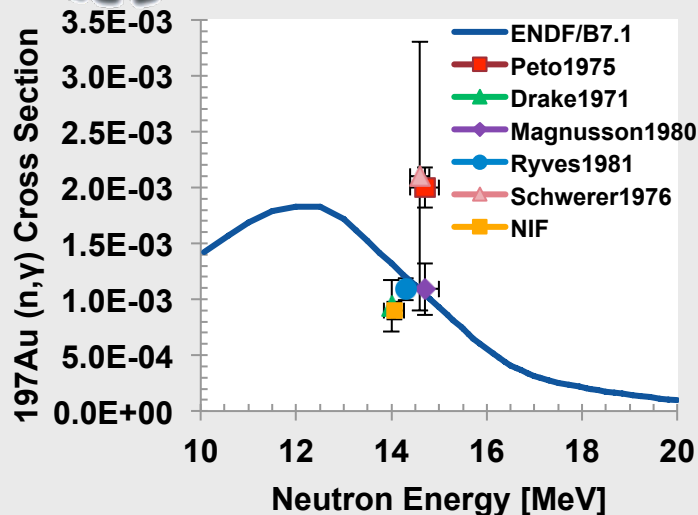
New capabilities to perform nuclear physics experiments have been developed

Neutrons from DT reactions can be used for nuclear physics



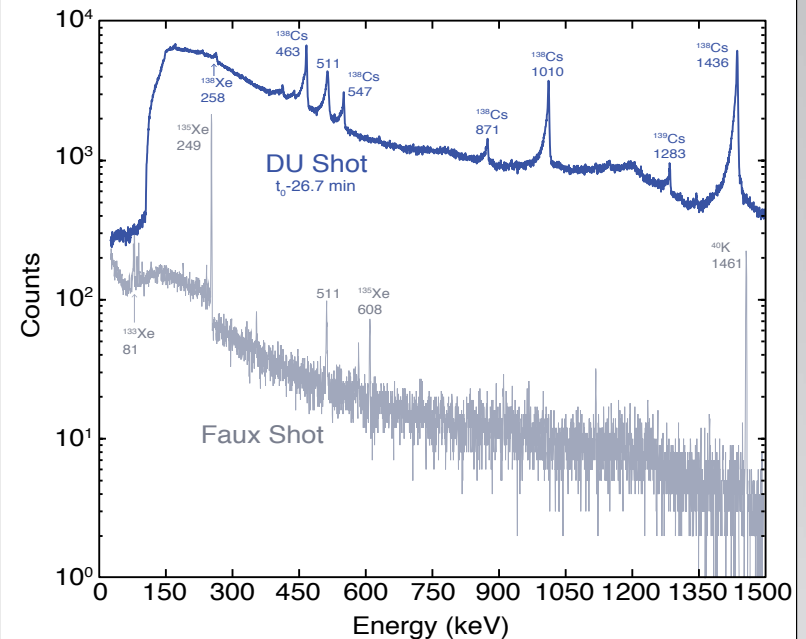
Au, U, B, Cu hohlraum wall materials have been used
Doped capsules are planned

$$Y \sim 10^{13} - 10^{16}$$



Quantitative cross section data has been acquired

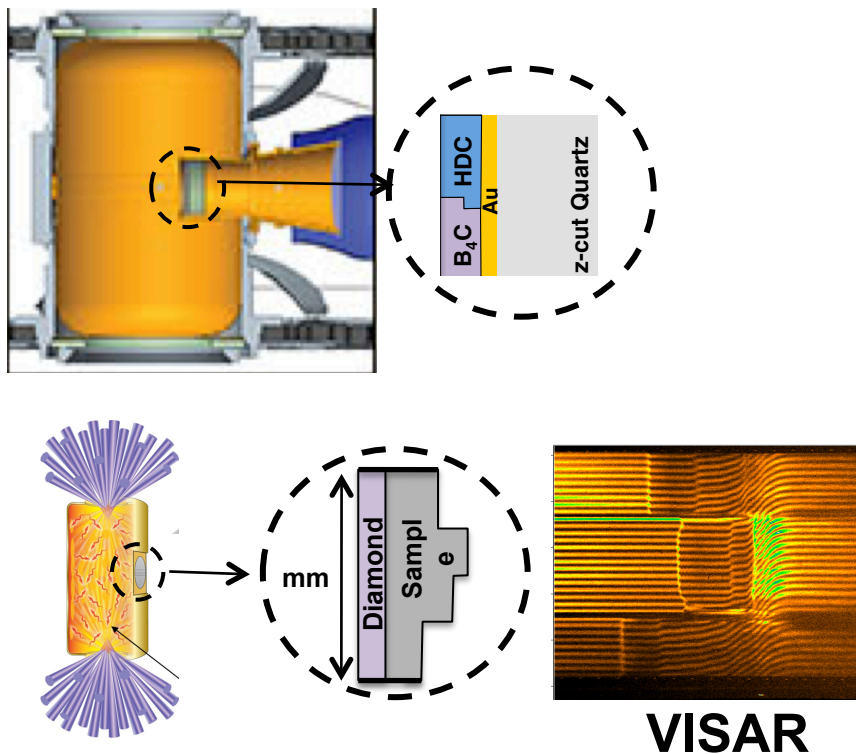
A gaseous radchem diagnostic has just been commissioned



- Potential experiments with nuclear reactions in a plasma
- Excited state nuclear physics
- Screening effects

Shock and ramp compression platforms allow the study of material physics: EOS, material properties, structure

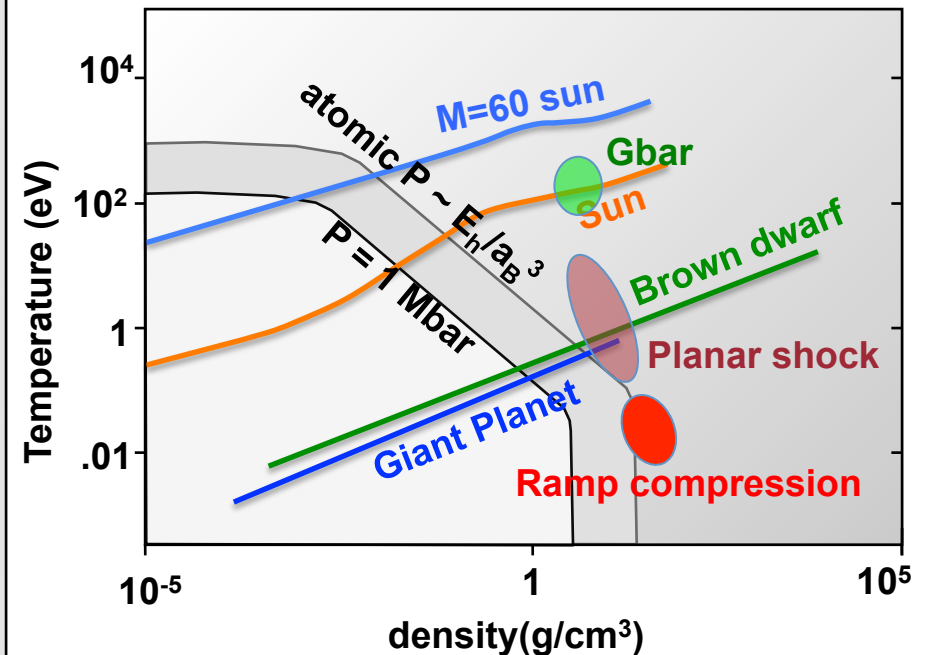
Keyhole and planar experiments reach ~100 MBar



~ 70 Mbars achieved in Carbon

Convergent experiments reached ~ 700MBar (Gbar)

Conditions reached are comparable to planetary interiors

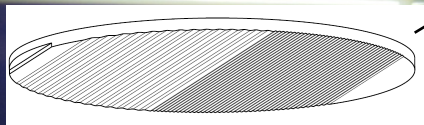


- Conditions of planetary interiors
- EOS
- Phase
- Material strength
- Pressure ionization at high density

Planar and convergent platforms have been developed for hydrodynamics experiments

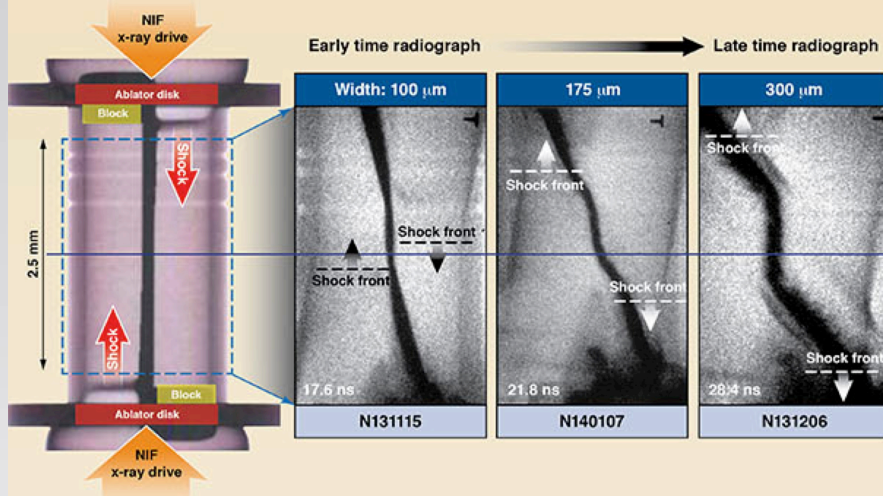
Planar experiments

sidelighter



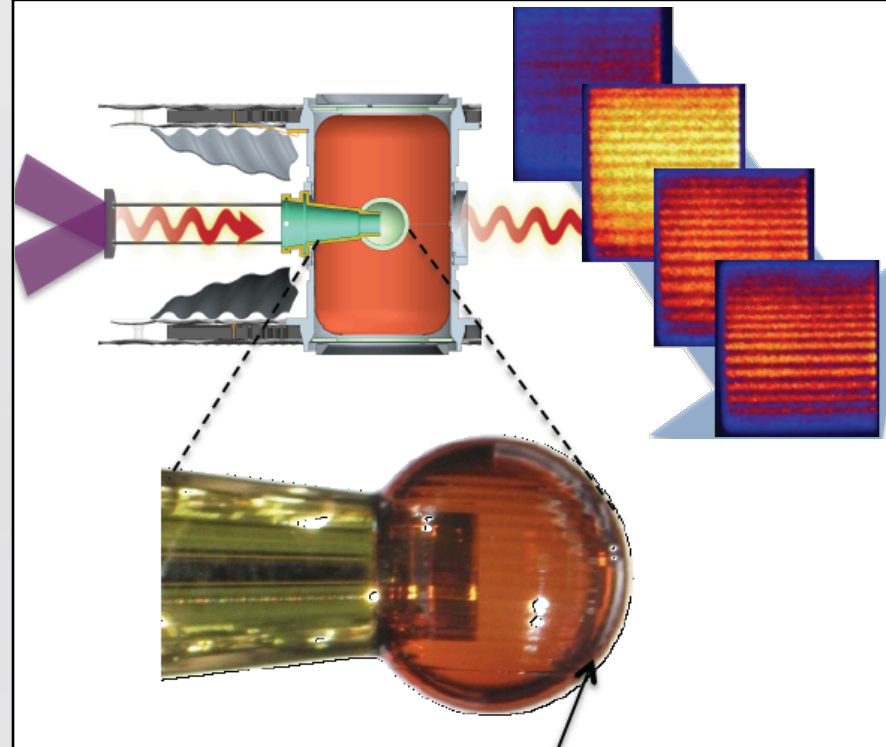
$$GF \sim e^{\gamma t} \sim 1000$$
$$\gamma \sim (z/\lambda)^5, z \sim 1\text{mm}$$

backlighter



A new double sided drive platform has been developed by LANL

Convergent experiments



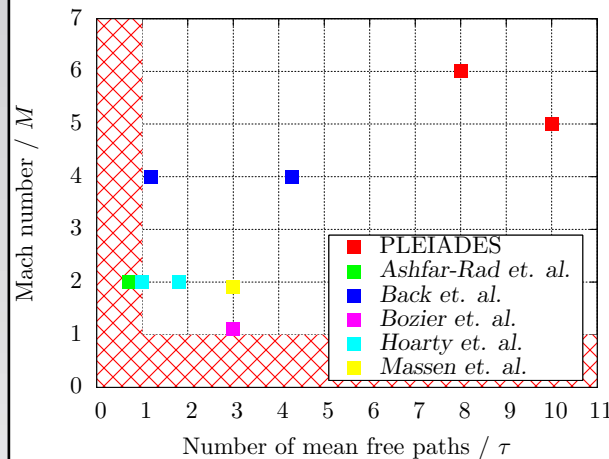
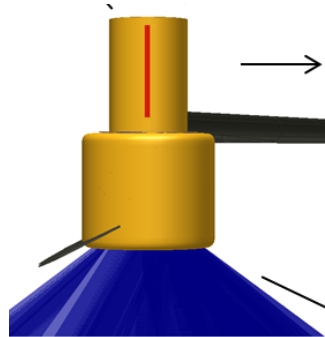
Sinusoids

Distance traveled $\sim 800\mu$,
convergence $\sim 3x$ for radiography

- RT, RM planar & convergent
- KH, counter-propagating RM planar

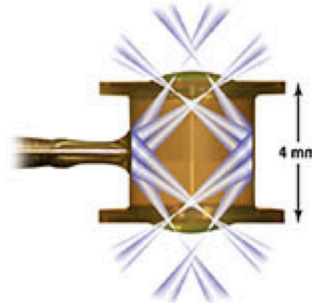
Radiation physics and LPI platforms

Supersonic radiation transport platform

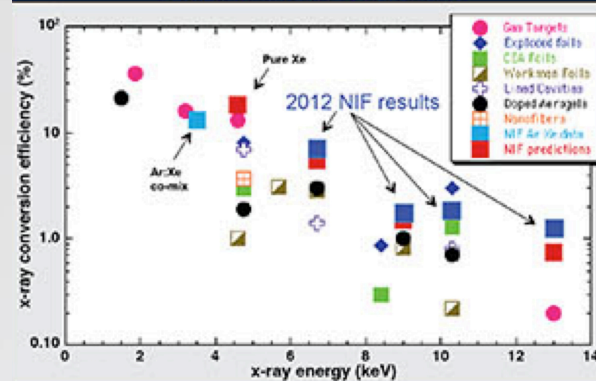


- Radiation transport in interstellar media

Volumetric, isotropic multi-keV X-ray sources

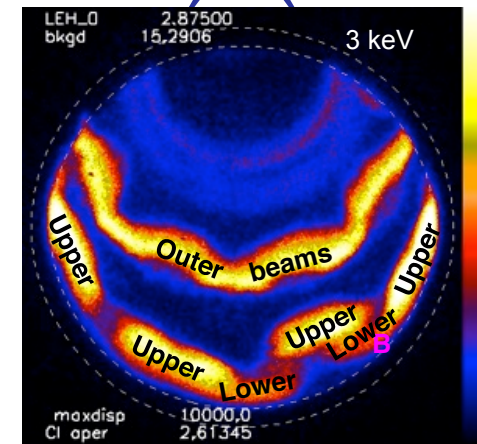
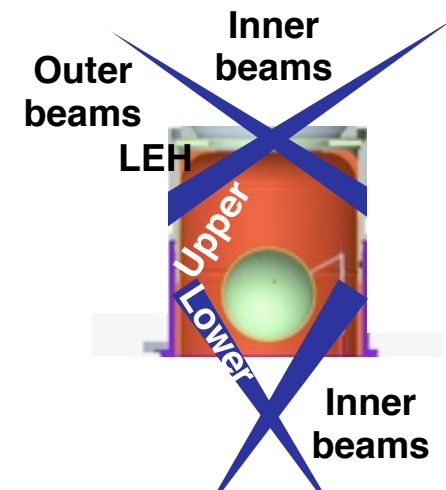


Gas filled bags
Metal cylinders



- Atomic physics
- LPI

Viewfactor platform



- Hohlraum physics

The list of available platforms have been tabulated and are available with references

Indirect drive implosions	Direct drive implosions	Shock timing and equation of state	Horizontal axis radiography
DT	PDD	Key	1DConA
Symcap	DIME	DT Keyhole	2DConA
CSym	ExpSh	Keyhole: 2axis	2D ConA THD
Warm SymCap		Keyhole: 3axis, m mode	ConAW
CDMix		Keyhole: 3axis, p mode	ConAW: Hifoot
Rugby		Keyhole: DT layer	ConAW: Gbar
ID Exp Push		Crystal Ball	Toto Radiography
		Keyhole: HGR	HGR
		Keyhole: Planar Ablator	TaRT
		EOS	AbIRT
		Diffraction Drive	
		Strength Dr	

Vertical axis radiography	Half hohlraum	X-ray conversion	Laser plasma interactions
2DConA	AbIRT	XRSD	Gas pipe
AbIRT	Fanbolt	X-ray Source	Hohlraum Energetics
	Menkar	MDAexposure	Reemit
	Pleiades	BL	ViewF
	RadT	Backlighter: 2D	Quart
	RTCal	Au Ball: Flat Field	
	RTStrk	Au Disk	
	Shktub		

Posters in each area with additional details are available in this meeting

Summary

- The use of existing platforms provides the opportunity to acquire data more readily than developing new platforms
- This strategy is consistent with mini-campaigns – more shots, more data
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**Providing more opportunities for data is vital for
Fundamental Science on NIF**



Identification of key scientific experiments can drive new capabilities required

Typical lead times prior to a NIF experiment			
Capability	Identical to existing platform	Small modification to existing platform	New capability
Targets	1 – 6 months	6 months – 1 year	> 1 year
Laser drive	~ 1 month	1 – 6 months	> 6 months
Diagnostics	~ 1 – 3 months	3 – 6 months	> 6 months
Data analysis	Exists	1 – 3 months	> 3 months